Mapping Hydrogen in the Galaxy, Galactic Halo, and Local Group with ALFA: The GALFA - H I Survey Starting with TOGS

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Abstract.
Radio observations of gas in the Milky Way and Local Group are vital for understanding how galaxies function as systems. The unique sensitivity of Arecibo's 305m dish, coupled with the 7-beam Arecibo L-Band Feed Array (ALFA), provides an unparalleled tool for investigating the full range of interstellar phenomena traced by the H I 21cm line. The GALFA (Galactic ALFA) H I Survey is mapping the entire Arecibo sky over a velocity range of -700 to $+700$ km/s with 0.2 km/s velocity channels and an angular resolution of $3.4'$. We present highlights from the TOGS (Turn on GALFA Survey) portion of GALFA - H I, which is covering thousands of square degrees in commensal drift scan observations with the ALFALFA and AGES extragalactic ALFA surveys. This work is supported in part by the National Astronomy and Ionosphere Center, operated by Cornell University under cooperative agreement with the National Science Foundation.

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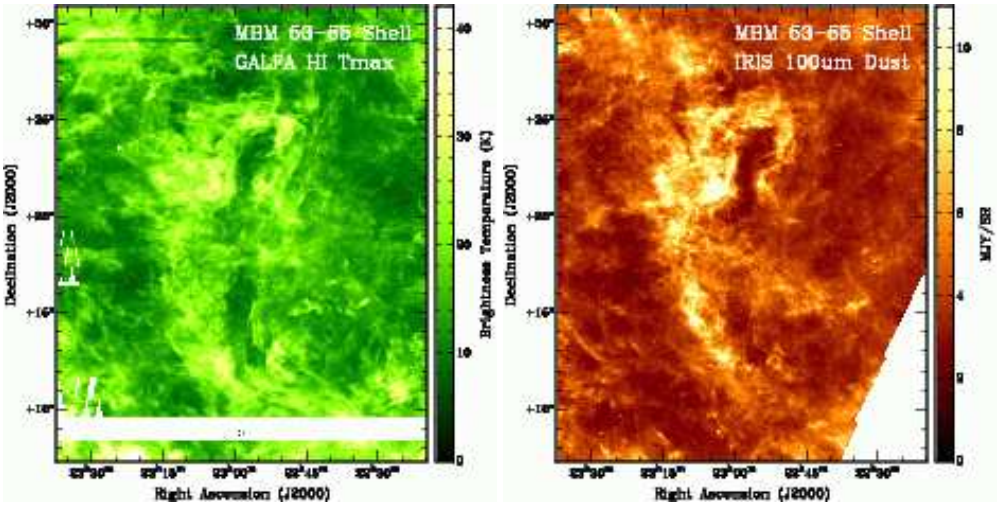

FIGURE 1. *(LEFT)* GALFA map of H I line peak brightness and *(RIGHT)* IRAS 100 micron thermal dust emission from the nearby molecular cloud complex MBM 53-55 [1], which has not yet formed many stars, but is likely to do so in the future [2]. The complex appears to be part of a large dynamic structure, perhaps an expanding shell [3]. GALFA sensitivity and resolution allows every IRAS filament to be velocity-mapped in H I, so the kinematics and temperature structure of the entire region can be thoroughly investigated. Many narrow-line H I features are present, indicating widespread cold atomic gas from which the molecular clouds may still be condensing (Gibson et al., in prep).

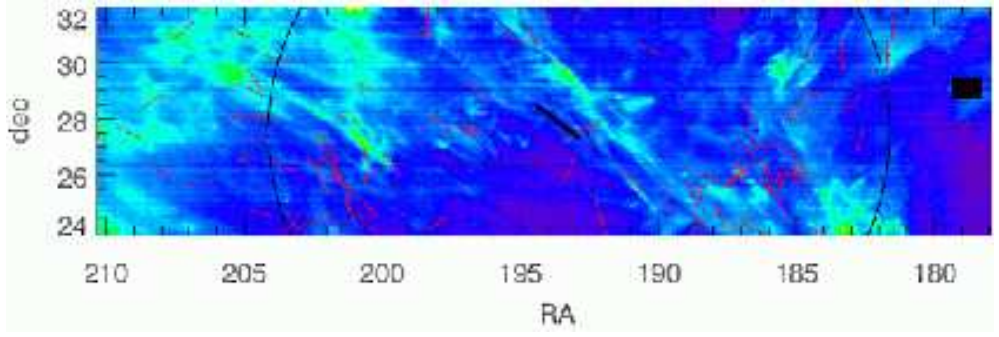

FIGURE 2. Bundles of very fine ($\sim 5'$ wide) filamentary H I features near the north Galactic pole. These features are highly correlated with optical starlight polarization measurements (red lines), implying magnetic fields running along their lengths. They are also roughly parallel to the local spiral arm. We find these "filament bundles" throughout the diffuse interstellar medium, suggesting a new technique for finding the orientation of magnetic fields (Peek et al, in prep).

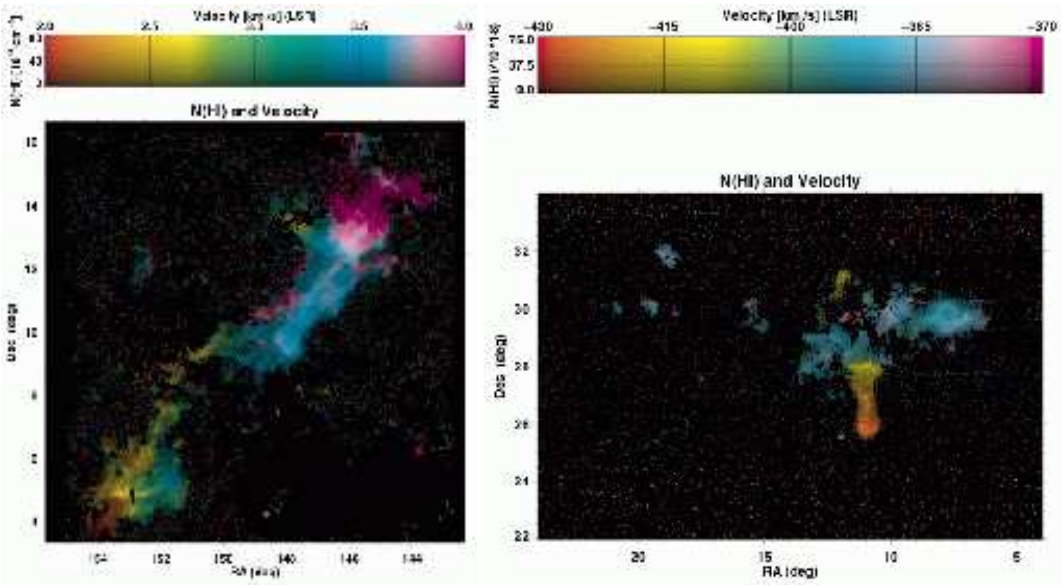

FIGURE 3. *(LEFT)* GALFA image of an extremely cold (17 K) and nearby (< 40 pc) H I cloud [4]. Color represents velocity along the sight line, and brightness represents hydrogen column density. Because of its location within the local hot bubble, this cloud makes a very interesting laboratory for the study of cold H I and cold/hot gas interfaces. A comparison of the 21-cm observations to infrared dust emission and optical and UV stellar absorption is underway (Peek et al., in prep). *(RIGHT)* GALFA reveals detailed structure of Very High-Velocity Clouds (VHVCs) in the halo and can be used to probe the diffuse halo medium through fingers extending off the sides of the cloud and head-tail clouds (e.g. [5, 6]; Peek et al., in prep; Grcevich et al., in prep).

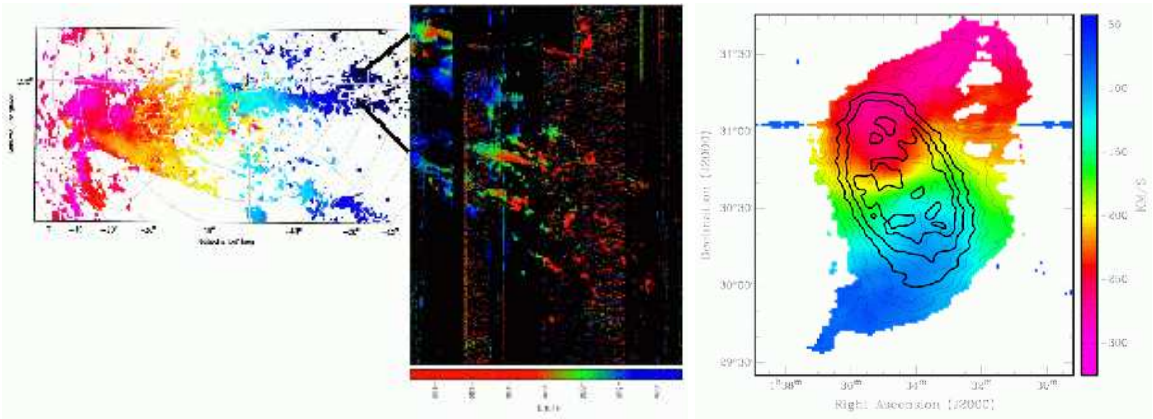

FIGURE 4. *(LEFT)* The H I velocity field of the Magellanic System from the Parkes telescope (15.5′ resolution; [7]). *(CENTER)* the tip of the Magellanic Stream as observed by GALFA, revealing four coherent 10-15 degree long filaments that differ in morphology and velocity structure and may have different origins/ages. Numerous small clouds with high negative velocities are also evident. Some of these clouds show evidence for a multiphase medium and may result from spatial fragmentation of the Stream due to thermal instability (Stanimirovic et al., in prep). *(RIGHT)* The Local Group galaxy M33 as seen by GALFA. What was traditionally thought to be a quiescent galaxy shows clear evidence for tidal/ram pressure disruption and/or gas cloud accretion (Putman et al., in prep).